

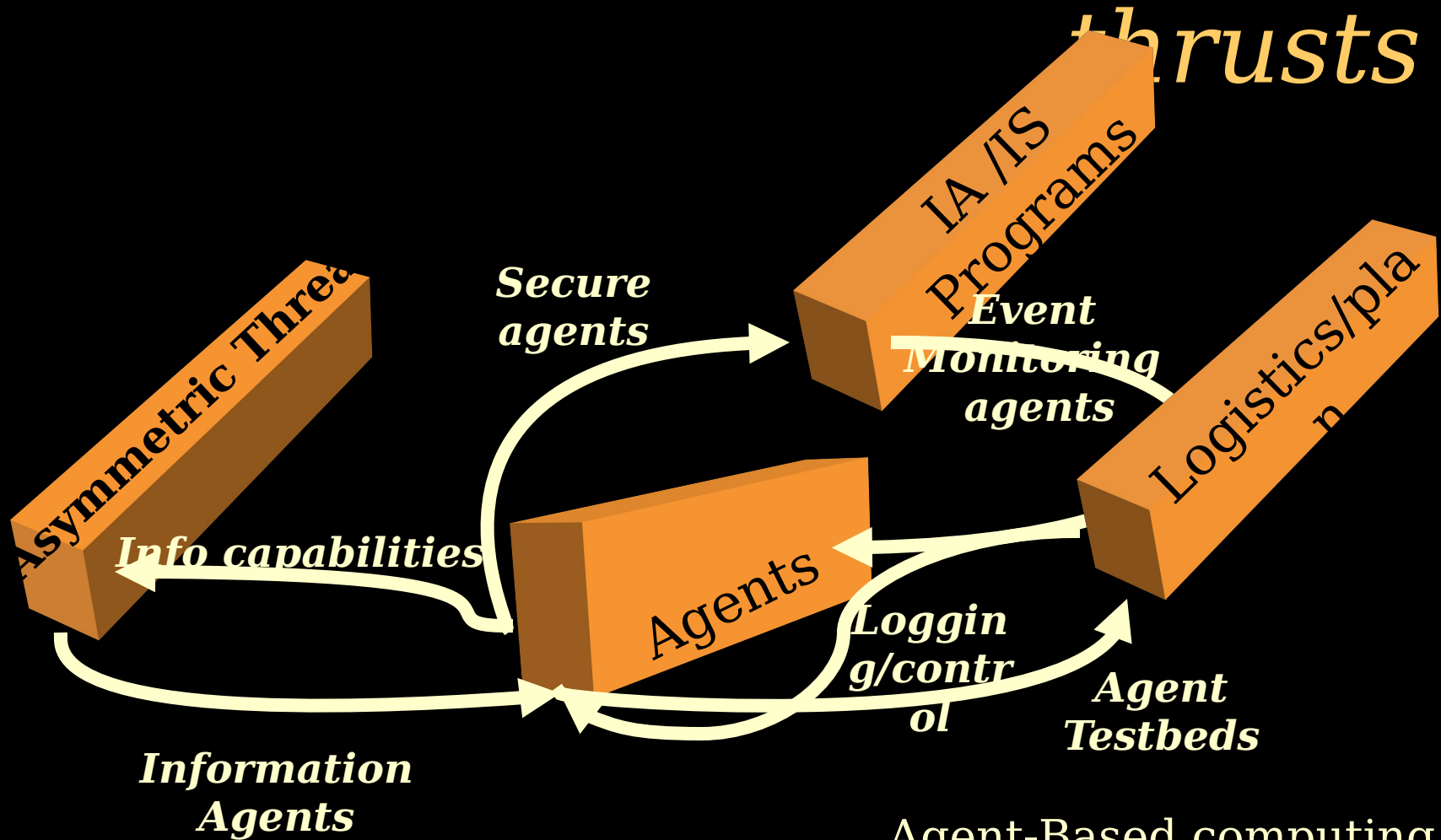
# Agent-Based Computing



## DAML DARPA Agent Markup Language

Jim Hendler  
DARPA  
Information Systems Office

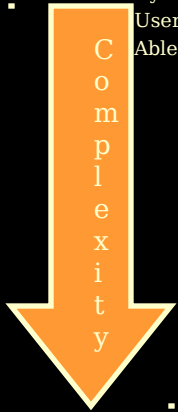
# *Agents are crucial to ISO thrusts*



Agent-Based computing is mandatory for delivering on the key ISO themes. As functionality is gained, all

# *What is an agent?*

- An agent is a software component or system that is:
  - Embedded in, and “aware” of, an environment
  - Dynamic in its behaviors (not single I/O mapping)
  - User enabled/steered, but “empowered” to act for user
  - Able to improve its behavior over time



Communicative

Autonomous

Capable

Adaptive

Environment

**Output(t+1)**

**Input(t)**

Real-time  
processing

Tuning  
and/or  
adaptation

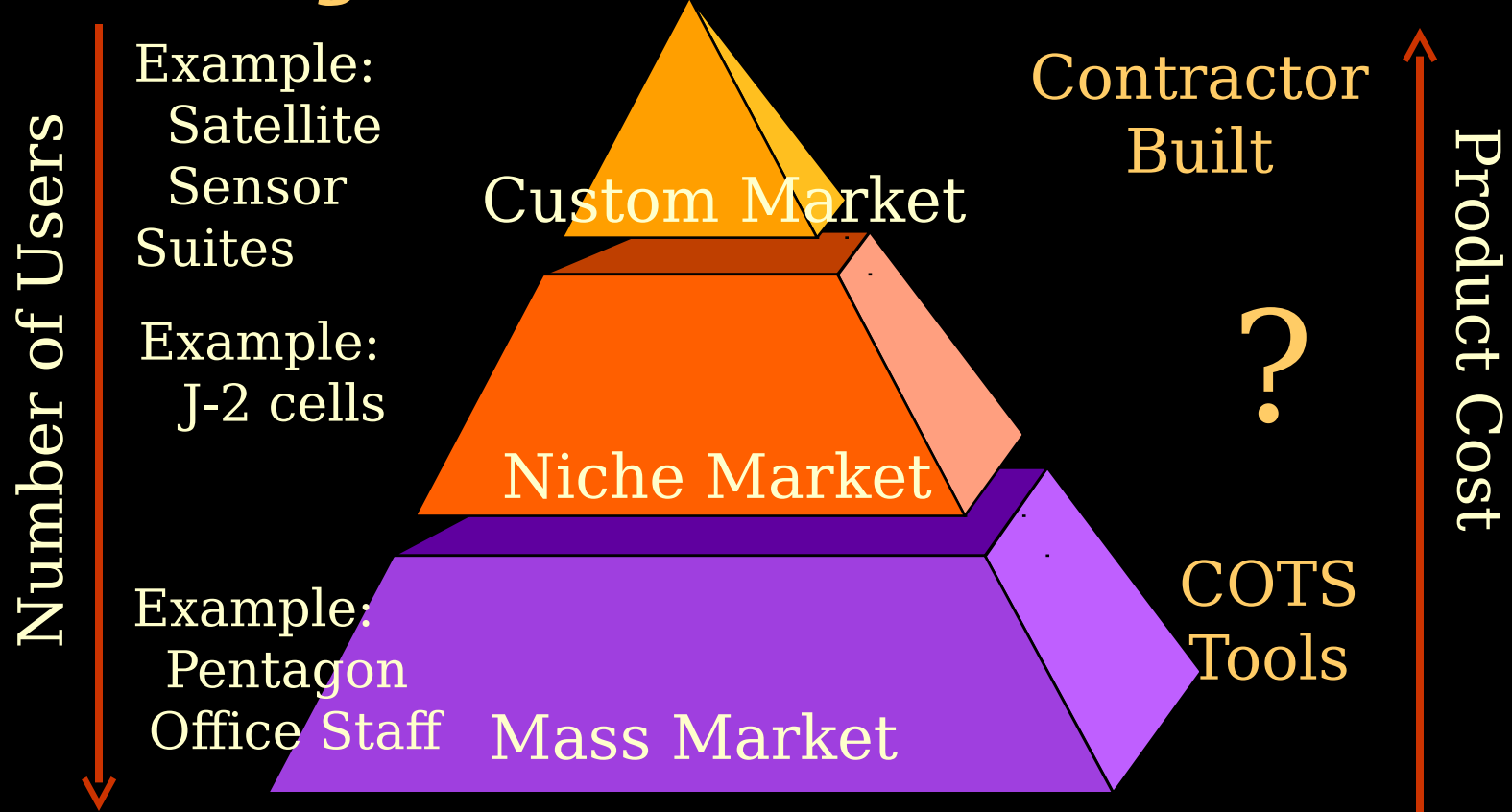
User/system goal assessment

**AUTONOMOUS**

**SOFTWARE**

These are  
desirable  
properties  
for software  
systems

# Military Tools



- The military is made up of many different markets
  - Some custom markets w/successful transitions
  - Some markets covered by COTS tools
  - Middle niche largely unsuccessful transitions
    - Custom code not POMed because other users won't pay
    - COTS tools won't address because of mil. specific needs
    - Tool cost outside IDIQ type arrangements

# *Military Task-Specific Tools*

What was the most important piece of software ever?

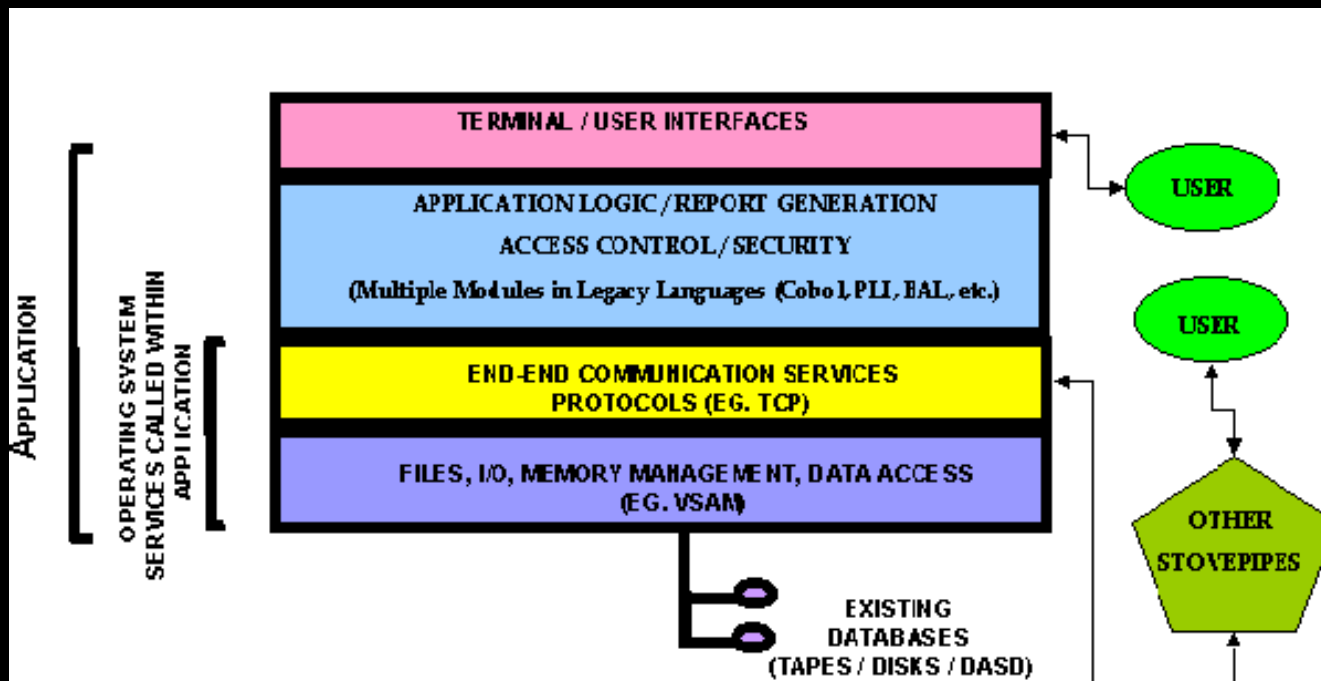
The original “killer ap” - **VISICALC** (now Excel)

- **Before**
  - Hire programmers
  - Explain your domain
  - Take versions as provided
  - Pay continually for update and maintenance
  - Dependent on outsiders
- **After**
  - “Programmed” in-house, users already know task
  - Immediate feedback/prototyping
  - Continually updated by users, in-house
  - no external dependence

Same story for Powerpoint - most used piece of “military

**Contention: Information Agents are a key enabling technology for building similar task-specific tools for military users.**

# *Why is this hard*



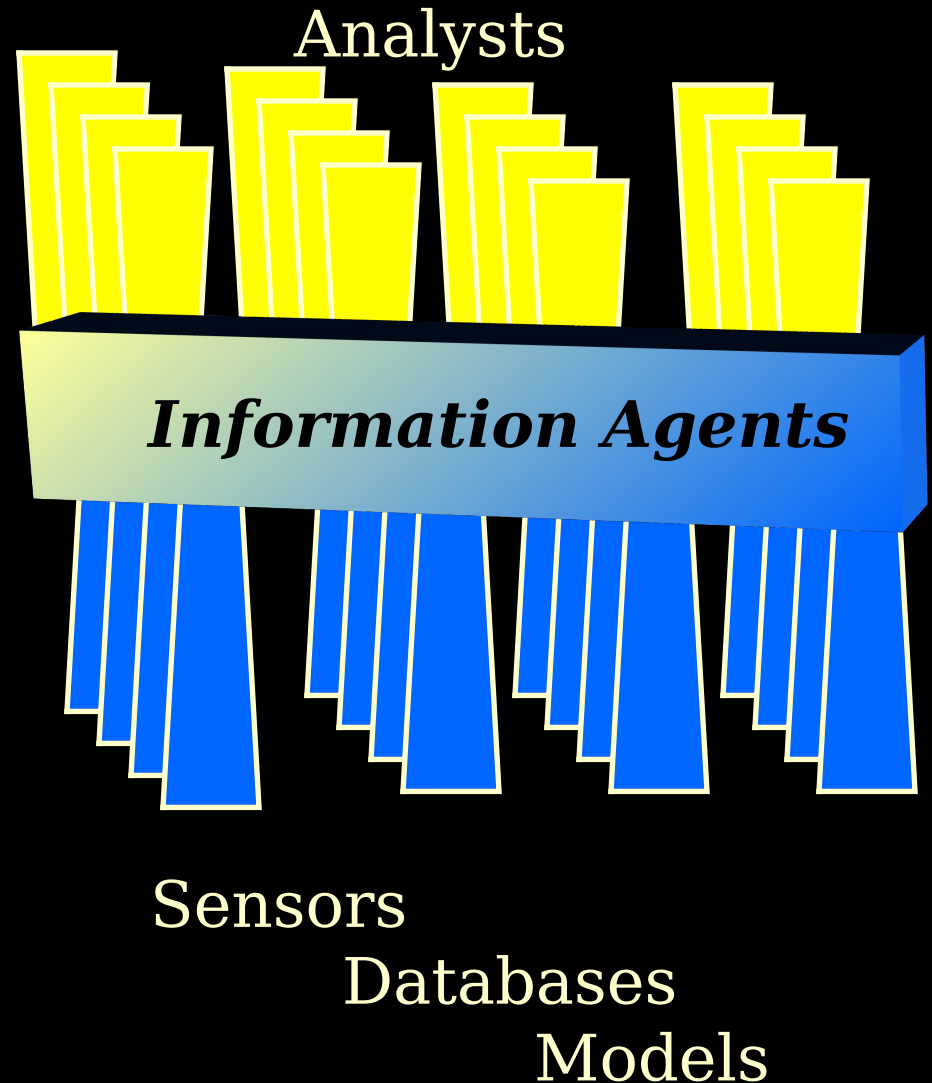
Most military information systems are in stovepiped systems

Difficult to get access to the sources

No mechanism for remote access

# *How Agents Help: Breaking down the stovepipes*

- Provide tools to help the run-time coupling of decision-making and analysis tools with appropriate data and sensing resources
- Development is focused on (shared) **information** needs



# Information Agents

MILITARY-SPECIFIC TASKS

Target Identification and Attack

AGENT CAPABILITIES

**Search**



**Collate**



**Identify**



**Update**



**Monitor**



Source Info

Resource Data

Capability Specs

Input Specs

Status Info

Interoperability Grid

EXISTING  
LEGACY &  
EVOLVING  
SYSTEMS

INTELLIGENCE  
PREPARATION  
OF THE  
BATTLESPACE

INDICATIONS &  
WARNING

SURVEILLANCE  
& SENSORS

TARGET/STRIKE  
PLANNING

ATTACK  
OPERATIONS



# *What does it take?*

- A three-program approach
  - I. A mark-up language for networked agents
    - ***DARPA Agent Mark-Up Language (DARPA AML)***
    - Must provide a mechanism for advertisement/capability specs
  - II. Software tools for creating the agents
    - ***Taskable Agent Software Kit (TASK)***
    - Must reduce per-agent development/customization cost
  - III. A middleware layer creates a “software grid”
    - Continuation of ***CoABS*** investment
    - Must be able to bring systems, sensors, models, etc. to the grid

*DARPA Agent Markup  
Language(DAML)*

# *Problem: shared representation*

- We never were able to develop monolithic data standards in the military(motivating this work in the first place)
  - Why should we be able to develop monolithic common-sense ontologies or agreed upon domain models for sharing the grid?
- Solution:
  - Develop usable interoperability technologies similar to those that enable the world-wide web to function

# *How do we attack this problem?*

- The key enabler of current interoperability in both military and commercial systems is the “HyperText Mark-up Language” (HTML)
  - Allows a machine readable, formal language, to be expressed on web pages for the presentation of data
    - limited set of tags
      - not useful for machine search

```
<Title> How do we  
attack this problem?  
</title>
```

# *Beyond HTML: adding syntax*

- Current languages attack this by adding syntactic data handling abilities
  - XML (eXtensible Markup Language)
    - Extensible keyword set
    - Solves syntactic inequalities between data formats
      - DB 1 -> ADDRESS <- DB 2
  - Useful for Data Sharing
    - Not search

```
<!--Element TITLE-BLOCK EMPTY-->
<!--ATTLIST TITLE-BLOCK Title #cdata required Subtitle #cdata
implied>
<Title-Block>
    <title> Beyond HTML </title>
    <subtitle> adding syntax </subtitle>
</title-block>
```

# Beyond XML: Agent Semantics

- DARPA will lead the way with the development of Agent markup Language (DAML)
  - a “semantic” language that ties the information on a page to machine readable semantics (ontology)
    - Currently being explored at University level
      - SHOE (Maryland), Ontobroker(Karlsruhe),OWL(Washington Univ)
      - Largely grows from past DARPA programs (I3, ARPI)

**<Title> Beyond XML**

**<subtitle> agent semantics </subtitle>**

**</title>**

**<USE-ONTOLOGY ID="PPT-ontology"  
VERSION="1.0" PREFIX="PP" URL=  
"http://iwp.darpa.mil/ppt..html">**

**<CATEGORY NAME="pp.presentation"  
FOR="http://iwp.darpa.mil/jhender/agents.html">**

**<RELATION-VALUE POS1 = "Agents" POS2 =  
"jhender">**

• But not transitioning

- W3C focused on short-term gain: HTML/XML

**<ONTOLOGY ID="powerpoint-ontology" VERSION="1.0"  
DESCRIPTION="formal model for powerpoint  
presentations">**

**<DEF-CATEGORY NAME="Title" ISA="Pres-  
Feature" >**

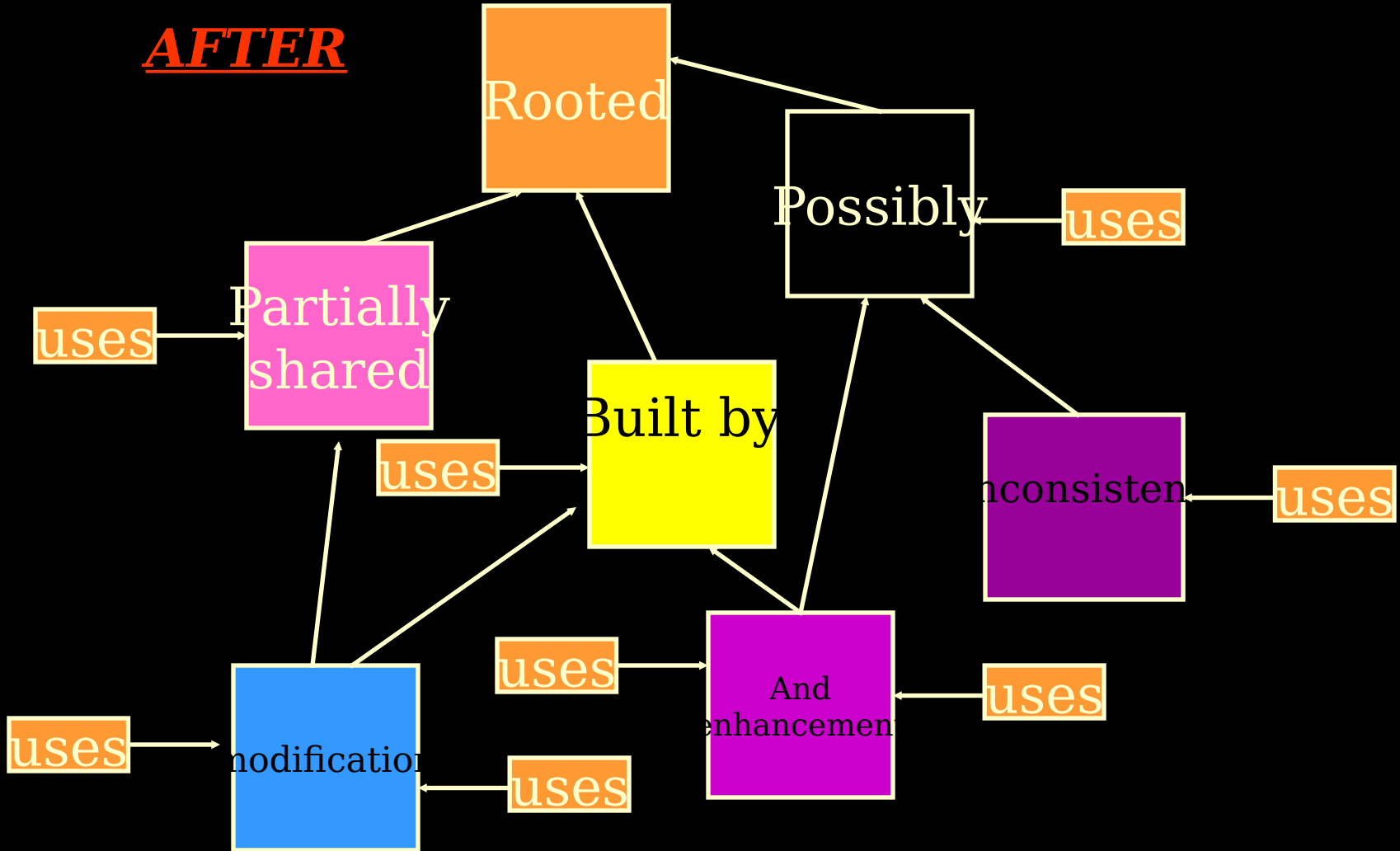
**<DEF-CATEGORY NAME="Subtitle" ISA="Pres-  
Feature" >**

**<DEF-RELATION NAME="title-of"  
SHORT="was written by">**

**<DEF-ARG POS=1**

*This leads to a radically new view of semantics!*

**AFTER**



# *A distributed ontological representation*

- Small communities define common semantics
  - Modifying existing components
    - adding terms
    - overwriting existing terms
    - deleting old terms
  - Creates a “rooted, directed, acyclic, graph” (rDAG)
    - Any two pages have at least one common ancestor
      - precisely defining shared terms
      - syntactically representable with a naming convention
  - Allows for an “ontology calculus” similar to the relational calculus that makes DBMS possible!
    - Will make “ontology management systems” a reality!



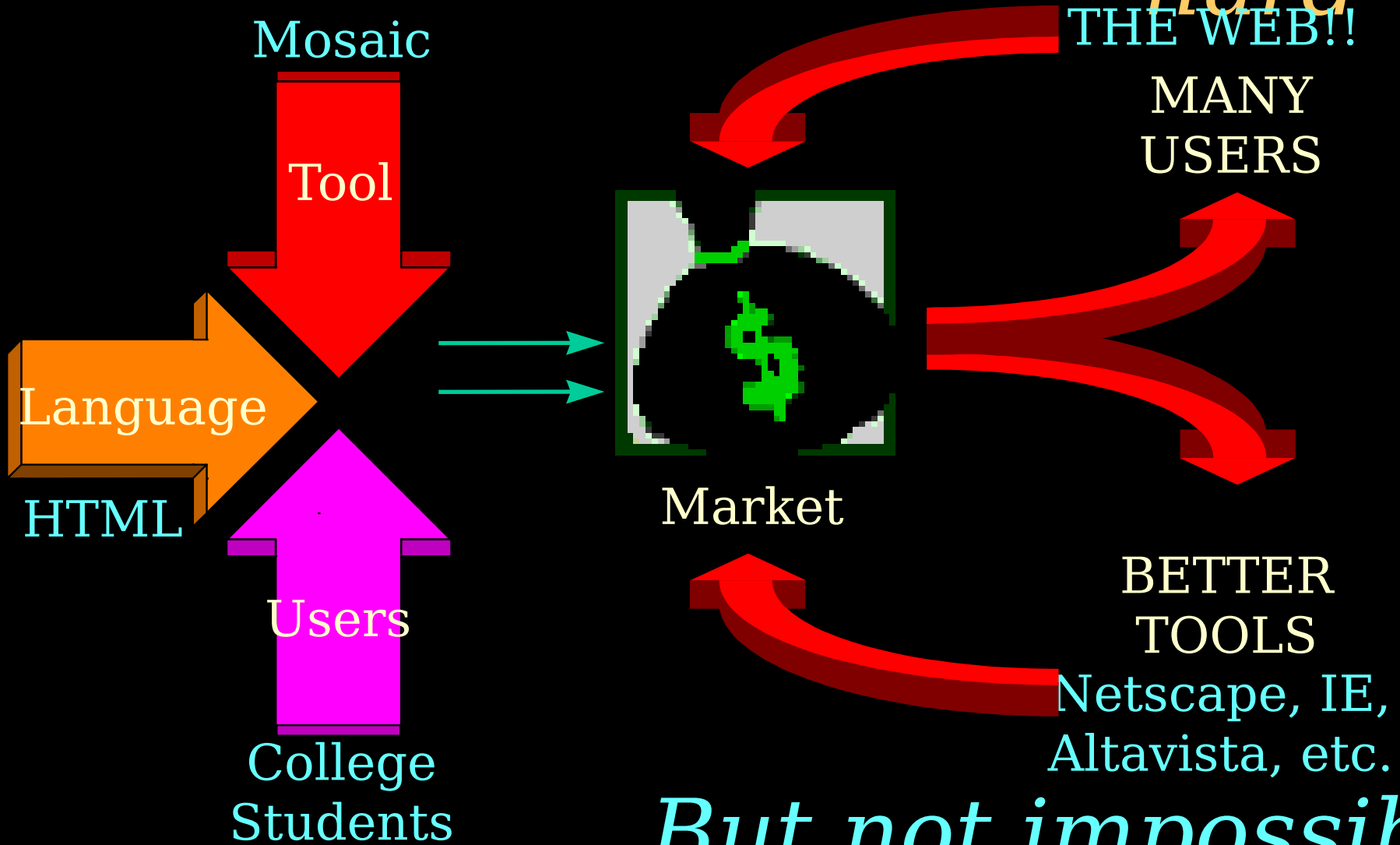
# Advantages

- Allows semantic interoperability at the level we currently have syntactic interoperability in XML
  - revolutionizing web interoperability
- Objects in the web can be marked (manually or automatically) to include the following **information**
  - Descriptions of data they contain (DBs)
  - Descriptions of functions they provide (Code)
  - Descriptions of data they can provide (Sensors)
- This marks the environment for agents!
  - Remember the dog analogy
    - This is the “scent,” as it were

# *Military Utility*

- Enables flexible tools for military software development and use
  - Information gathering
    - Agents can use DAML/ontology for search
  - Software development
    - Algorithms/code fragments advertise critical properties
  - Coupling of legacy systems
    - “Agentization” of systems enabled through grid interoperability mechanisms
      - advertise capabilities in DAML

# *Language adoption is hard*



*But not impossible*

# *DAML will do the same*

- DARPA funds language development
  - DAML instead of HTML
- DARPA funds “Killer Ap”
  - Intelligence tools for InteLink
- Tool released to military
  - Tools generate DAML links
- Market formed
  - 55,000 (and growing) users of InteLink  
enough to attract business investment

- Military spends a huge amount of time creating briefings

- gathering, collating, formatting data
- translating into powerpoint slides
- customizing for different commanders

- Need for a Personalized Briefing Creation Agent

- Knows about military domain  
(communicative)
- Knows how to access military sources  
(capable)
- Gathers information off-line for user  
(autonomous)
- Tailorable to users needs and changing resources  
(adaptive)

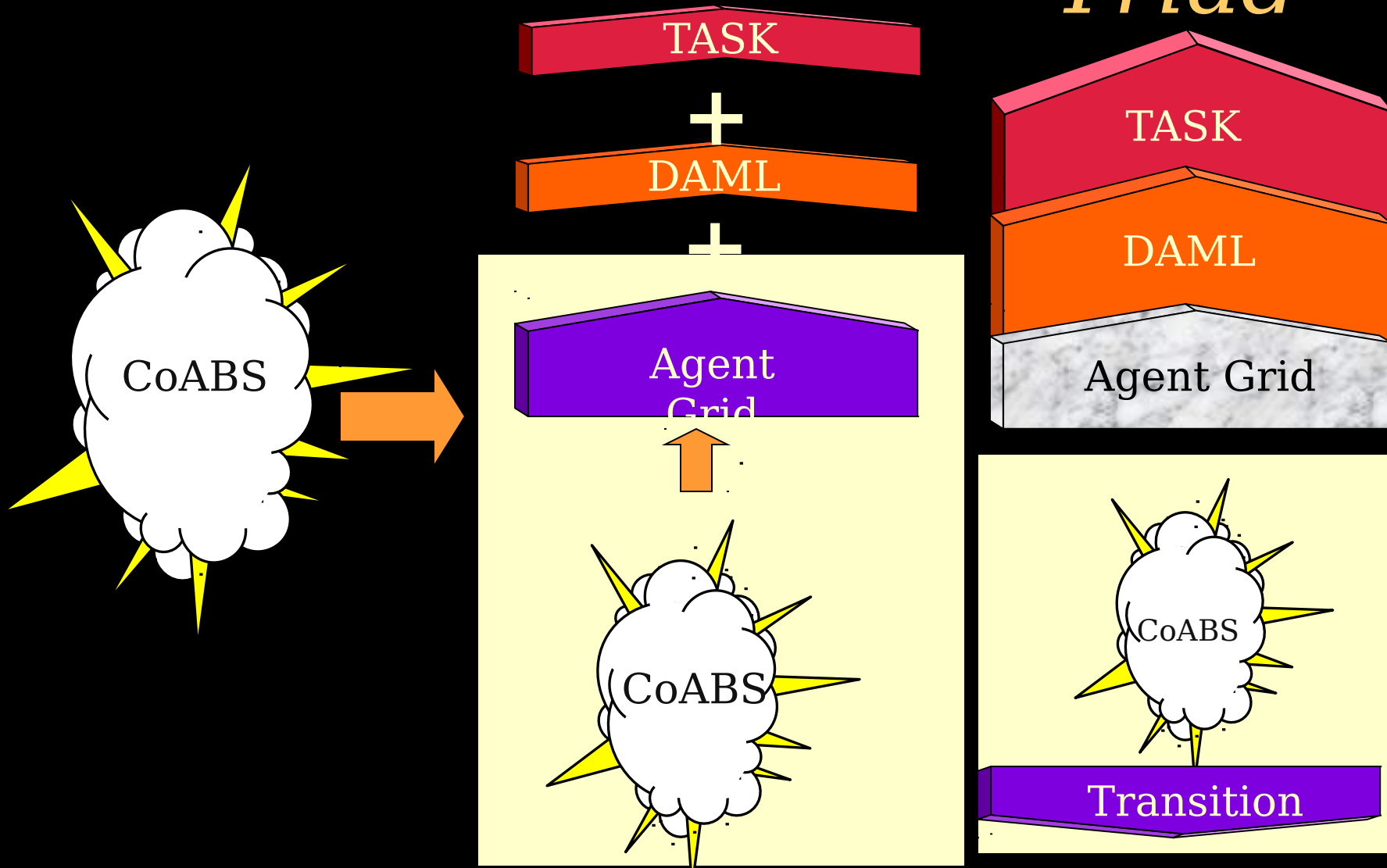
- Need for a search tool for information embedded in briefings

- IntelLink minimally keyword searchable

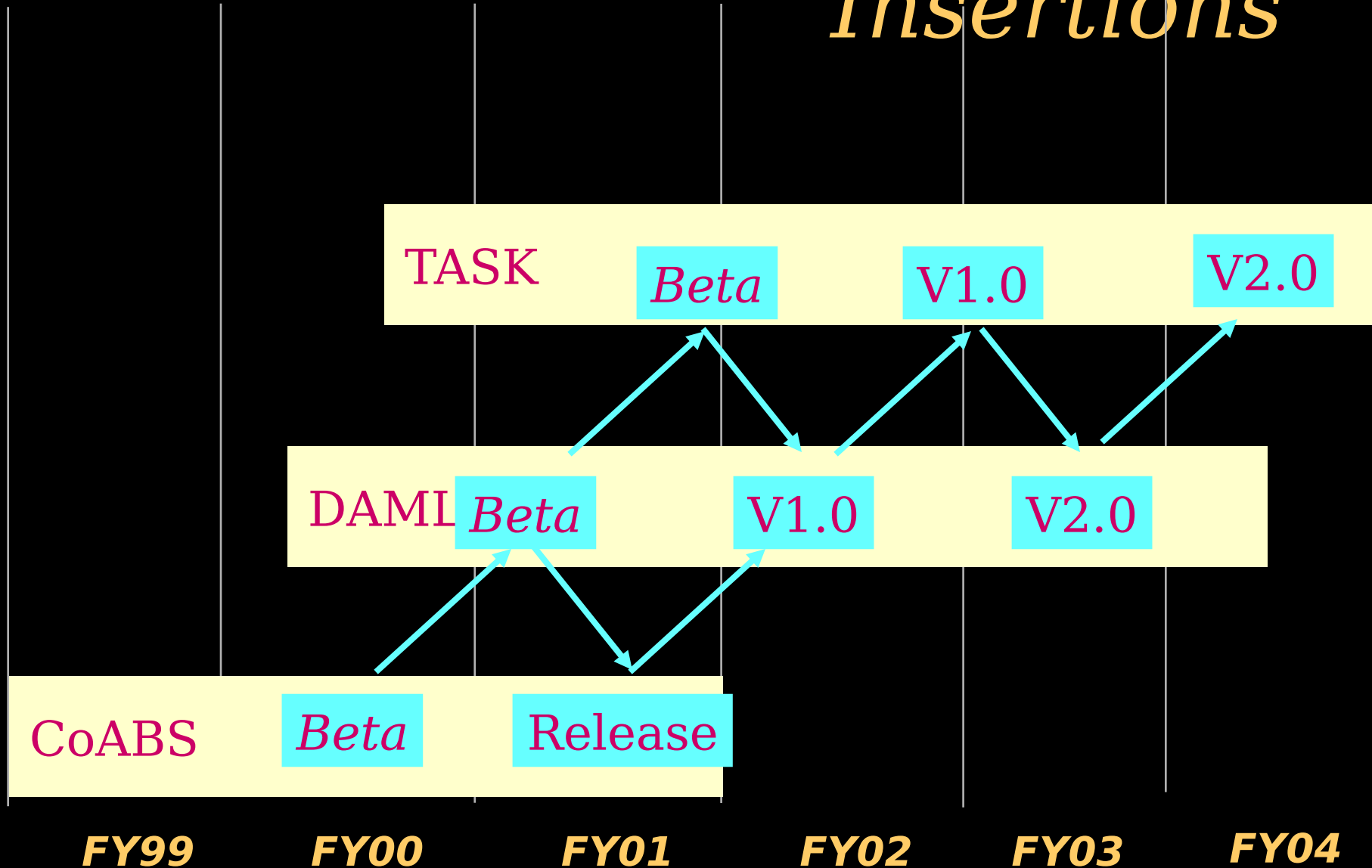
# *The Killer Ap*



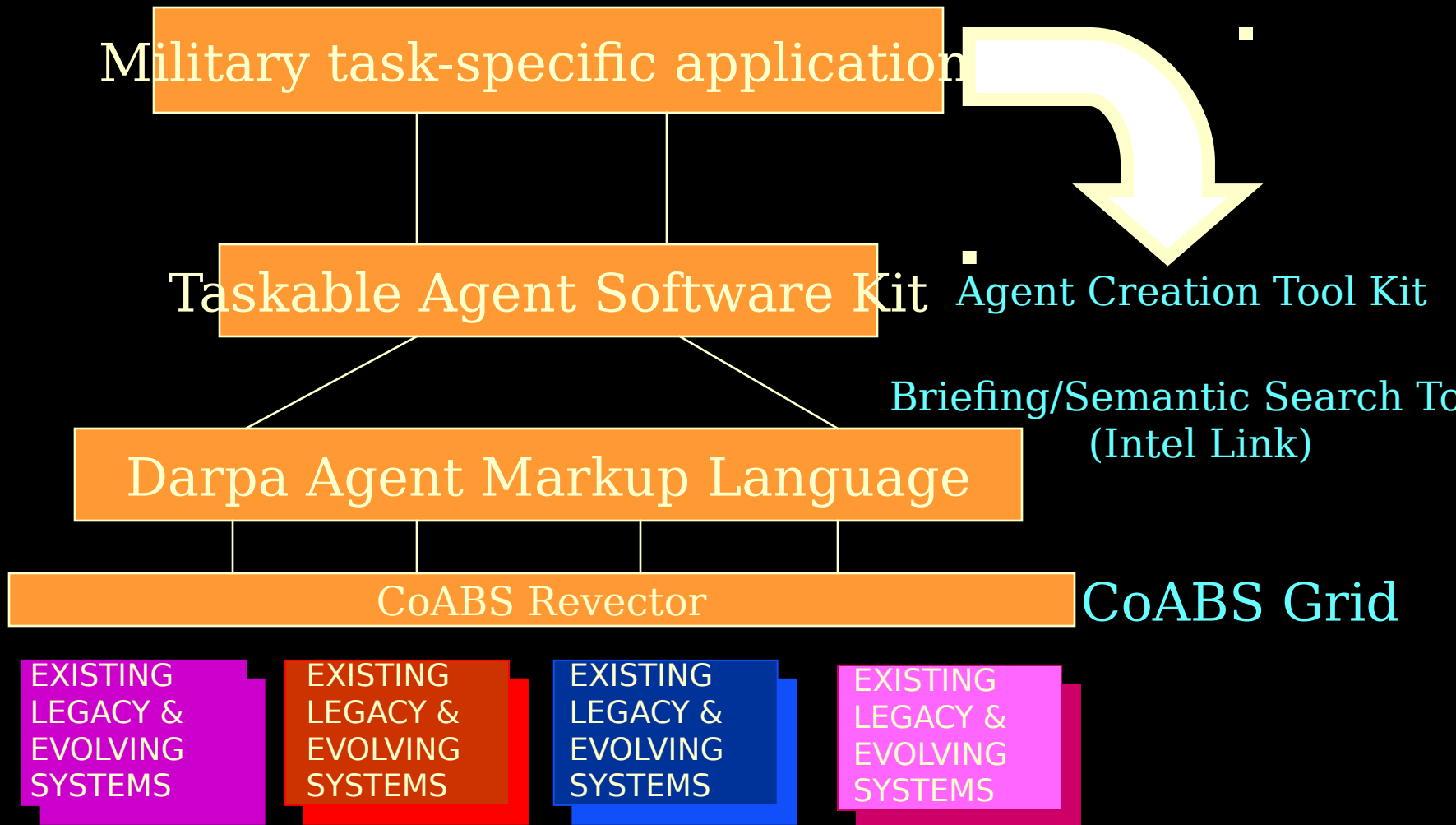
# *Agent Based Computing Triad*



# *Scheduled Technology Insertions*



# *Leave Behind*





# *Final Thought*

*Are the information people in MIS and IT prepared for the revolution? I see no sign of it so far.*

(P. Drucker, Forbes, Aug. 1998)

***DARPA must lead the way!***

END